COMMITTEE OF VISITORS

PLANT GENOME RESEARCH PROGRAM

FINAL REPORT

National Science Foundation
Arlington, VA

August 31 - September 2, 2010

Dr. J. Clark Lagarias, Chair	09-02-2010 Date
Dr. David B. Stern, BIO AC	2 Sept 2010 Date
Dr. Mary Alleman	9-2-10 Date
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Self Study Final

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question*.* Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE** If "Not Applicable" please explain why in the "Comments" section.
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The COV reviewed the 83 sample jackets randomly selected to represent the 394 actions taken by the PGRP over the period 2007-2009. The COV agreed that combined use of panel, *ad hoc* reviews and site visits (when appropriate) works well and provides a robust and equitable review process for each proposal submitted to the program. Panel review is waived for SGER/EAGER, RAPID and workshop proposal, allowing PGRP management to respond quickly and effectively to time-sensitive and/or potentially transformative yet high-risk pilot project opportunities. The COV notes that for all jackets reviewed, all appropriate documents were included in the jacket, and sufficient rationale for the funding decision was provided to the PI.	YES
2. Are both merit review criteria addressed? A. In individual reviews? Yes B. In panel summaries? Yes C. In Program Officer review analyses? Yes Comments: The COV notes that over the period reviewed, virtually every review, panel summary and review analysis addressed both criteria.	YES
3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: The COV noted that individual proposal ratings vary quite a bit from reviewer to reviewer and thus substantive comments are essential to an understanding of the review rating. The COV agreed that the overwhelming majority of individual reviews (both from panel members and *ad hoc* reviewers) provided meaningful comments that justified their overall rating of the proposal. Most reviews described both strengths and weaknesses of the proposal and attempted to highlight larger criticisms (as opposed to smaller issues). In addition, most reviewers provided comments about the appropriateness of the proposal for PGRP as well as the potential impact of the project on the greater plant research community.	YES
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: The COV notes that each sample jacket evaluated contained a panel summary indicating consensus. In general, panel consensus is implied through the panel rating and supporting rationale. The COV agrees that the panel summaries contained sufficient information to justify the panel rating.	YES
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) Comments: Each jacket evaluated by the COV contained at least three reviews, a panel summary, a contextual statement, a review record and a review analysis written by the program officer. The only exceptions to this are SGER/EAGER and workshop proposals for which external review is waived. In addition, the COV notes that the review analysis provided for each jacket was complete and addressed the rationale for the funding recommendation, any conflicts of interest, and both review criteria (as well as any applicable specialized criteria). Finally, each review analysis in the sample evaluated by the COV clearly addressed: 1. rationale for declination in all cases in which a proposal received an Excellent review and 2. rationale for funding in all cases in which a proposal received a Fair or Poor review.	YES

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) YES

Comments: The COV agreed that the documents/communication provided to the PI clearly indicate the rationale for the funding decision. In some cases, PGRP responded to subsequent PI inquiries with additional information.

7. Is the time to decision appropriate? Note: Time to Decision –NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later.** The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. YES

Comments: The COV notes that due to the size and the multidisciplinary nature of many of the proposed projects, it may be necessary for PGRP management to conduct site visits before a funding decision is made. In addition, the PGRP has been understaffed and has moved from DBI to IOS in the past year. The COV feels that the PGRP has worked diligently and, in spite of these major challenges, has met this goal. The COV expressed concern that there was an increase in the number of proposals with a dwell time >12 months from 2007 to 2009. Most of these proposals were held over for funding in the next cycle. The remaining proposals were for CAREER awards; for these, the proposal deadline was in July but the PGRP panel did not meet until the following spring. The COV understands that the timing issue with CAREER proposals has been addressed in the current funding cycle.

8. Additional comments on the quality and effectiveness of the program's use of merit review process: The COV feels that there has been a significant improvement over time with regard to review of broader impacts. The COV feels that there is much better general knowledge of what is meant by Broader Impacts within the community and that as a result, PIs submit proposals with well thought out and meaningful Broader Impacts. In addition, the COV feels that the PGRP is doing an excellent job of ensuring fair and equitable review of both criteria (Intellectual Merit and Broader Impacts). On the other hand, assessment of the effectiveness of Broader Impacts is difficult and restricted to Project Reports. In this sense it is unclear what is working and what is not.

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

Selection of Reviewers	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE** If "Not Applicable" please explain why in the "Comments" section.
1. Did the program make use of reviewers having appropriate expertise and/or qualifications?	YES
Comments: The COV recognizes that reviewer selection is a critical aspect of the review process and it is clear that PGRP Program Officers utilize a variety of approaches to identify the appropriate set of reviewers. In addition the COV recognizes that PGRP proposals are often multidisciplinary and thus require a set of reviewers with diverse expertise. The COV agreed that the PGRP program does an excellent job of recruiting reviewers with appropriate expertise.	
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information.	YES
Comments: With regard to geographic distribution of reviewers, the COV notes that the PGRP recruits reviewers from the majority of states and although some states clearly had many more reviewers (e.g. CA), this likely represents the total state population and density of plant biologists in the state. The majority of reviews from known institution types are from research-intensive PhD institutions, but the program has successfully recruited reviewers from a variety of institution types.	
3. Did the program recognize and resolve conflicts of interest when appropriate?	YES
Comments: The COV feels that the PGRP staff does an excellent job of conflict discovery and resolution. The panel review system is helpful in that panelists identified as COI for a particular proposal are excluded from viewing that proposal. In addition, panelists in COI with a particular proposal leave the room during discussion of the proposal in question. For the sample jackets provided, the COV notes that all conflicts are documented in the Review Analysis. This essentially follows standard procedures in BIO.	

4. Additional comments on reviewer selection: The COV recognizes the difficulties associated with obtaining an adequate number of reviews to properly evaluate a large number of multidisciplinary proposals. The COV feels that the merit review process employed by the PGRP is robust and fair.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE If "Not Appropriate" please explain why in the "Comments" section., OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program.	Appropriate
Comments: After review of documents provided in the eJacket, program information, and research highlights, the COV concluded that the quality of funded proposals in the PGRP is high and the funded projects well align with two five year plans of the NPGI and the NSF's strategic goals for Discovery, Education and Infrastructure. Research funded by PGRP is well represented by potentially transformative and high risk projects judged the most meritorious by rigorous peer review. High impact multidisciplinary research funded by PGRP notably includes potential agriculture- and health-related applications, such as corn biofortification to address vitamin A deficiencies (Doebley 0321467 and Hake/Quail 0604923), as well as the improvement of grain protein content for human nutrition. These examples highlight successful implementation of the previous COVs recommendation that PGRP support plant genome research of particular relevance to improved human nutrition. A valuable approach to shepherding research in emerging areas has been PGRP's successful call for Heterosis Challenge Grants (HCG). These, along with SGERs/EaGERs, are expected to lead to larger, more comprehensive proposals in extremely important areas where genomic approaches will provide great insight. Education programs supported by PGRP include the funding for over a dozen workshops to foster interactions, training and advancement in the entire community and funding to encourage the entrance of new individuals not previously working at the genomics/systems level to careers in plant biology. Such endeavors are also designed to foster coordination and collaboration amongst diverse investigators from many fields of science. PGRP continues support of the most highly used databases and website resources in plant biology, e.g. Gramene and MaizeGDB, as well as new tools (eg. gene targeting, remote visualization of plant growth) that should be of widespread value to the greater plant biology community.	
2. Does the program portfolio promote the integration of research and education?	Appropriate
Comments: PGRP solicits the integration of research and education in all proposals. Thus, funded PGRP projects promote both research and education endeavors. Specific examples of the integration of research and education include projects that support teacher internships designed to bring plant genomics (Chandler 0321663 and Nguyen 0211842) and bioinformatics information and training (Napoli/Jorgensen 0421679) into high schools through the training of high school teachers during summer research experiences. The COV recognizes that such efforts impact a large number of individuals beyond the individual teachers trained in these programs. Other examples are discussed in section B.2.	
3. Are awards appropriate in size and duration for the scope of the projects?	Appropriate
Comments: PGRP fully funds highly competitive projects whose budgets are well justified. From our analysis, very few budgets of funded grants were programmatically increased or decreased without adequate justification (e.g. changes in award duration). Award sizes appear appropriate for the work proposed and are proportionate for the number of individuals and institutions associated with projects for awards provided in the eJacket.	
4. Does the program portfolio have an appropriate balance of:	Appropriate
• Innovative/potentially transformative projects? Comments: PGRP supports the most meritorious proposals while balancing transformative/high risk research, tool and/or resource development along with education. An notable example includes the project funded by PGRP to develop zinc finger nucleases to improve site-directed gene targeting in plants (Voytas 0501678). Additionally, PGRP funded 9 SGERs/EAGERs and 9 HCGs during the review period. These funding mechanisms are designed to support high-risk, exploratory and potentially transformative research. The COV observes that this number of SGERs/EAGERs awarded is less than previous cycles, however many standard PGRP-funded projects are high risk/transformative, so the apparent decline in the number of funded SGERs/EAGERS is not necessarily meaningful.	
5. Does the program portfolio have an appropriate balance of:	Appropriate
• Inter- and Multi- disciplinary projects? Comments: Based on self-identified multidisciplinary awards, approximately half of PIs reported that their awards (i.e. 52 out of 106) are associated with 2 or more disciplines (see answer to question 10 below). As the larger PGRP funded projects are inherently multidisciplinary, the COV concluded that this proportion is not unexpected. *Recommendation*: As there are no specific targets for the balance of inter- and multidisciplinary projects, the COV felt that it would be useful for the program to comment on how they view the performance of such awards. Providing performance metrics as listed in Section C3 would facilitate assessment of the portfolio.	

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Appropriate

Comments: As was observed by the 2007 COV, the PGRP makes the majority of its awards to projects with multiple PIs (approximately 65% of the total between 2007 and 2009, which is slightly lower than the previous cycle). Because of the interdisciplinary nature of plant genomics, the emphasis on multi-investigator awards is appropriate for the resources available to program. Of particular note, PGRP is providing the infrastructure to bring together groups of scientists to tackle large problems that could not be undertaken by individual researchers.

7. Does the program portfolio have an appropriate balance of: Appropriate

- Awards to new investigators? NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant. Comments: When new research niches open up and new technologies emerge, new investigators are positioned to take advantage of such opportunities. The number of new investigators associated with the 74 new awards over the review period makes up about half of the total number of investigators (107 vs. 257). While neither the PGRP nor NSF has explicit targets, this number appears to be appropriate. Projects that pair senior and young investigators offer the potential to be good mentoring devices for their professional development.

8. Does the program portfolio have an appropriate balance of: Appropriate

- Geographical distribution of Principal Investigators? Comments: To ensure that PGRP is serving the needs of the entire scientific community it strives for a geographically diverse portfolio of PIs. An analysis of the distribution of PIs and co-PIs on new awards funded by the Program between FY2007 and FY2009 shows that of the 74 regular competition awards, there were 257 unique investigators in 37 states. Because of the national significance of plant genome research and the concentration of technologies in key centers in the U.S., even geographical distribution of grant funding may not be the most efficient use of limited resources to solve important problems. It appears that the distribution of funded projects matches that of the proposals submitted.

9. Does the program portfolio have an appropriate balance of: Appropriate

- Institutional types? Comments: PGRP works to create a balanced portfolio of awards to all types of institutions. As expected given the scope of funded projects and infrastructural support generally associated with competitive PGRP proposals, the majority of program awards are to research intensive PhD granting institutions (80 out of 106 total). In support of their goal of balance, the PGRP continues to fund projects at a range of institutions, i.e., 26 awards at non-research intensive institutions during 2007 – 2009. Notable is a funded project (073470 Kantety) with Alabama A&M University, a Historically Black College/University and Master's Colleges and Universities I (Carnegie Classification), as the lead institution. An award such as this supports multiple goals of PGRP, including balance in both institutional types and in the promotion of the participation of underrepresented groups.

10. Does the program portfolio have an appropriate balance: Appropriate

- Across disciplines and sub-disciplines of the activity? Comments: Before funding decisions are finalized, program officers strive to ensure adequate representation of relevant scientific disciplines after a portfolio review. Upon review of the eJacket and information provided by PGRP, the COV determined that the PGRP's portfolio is sufficiently diverse in regards to types of cross-disciplinary research. A range of additional disciplines are represented in funded projects, e.g. Computer Science, Chemistry, Mathematics, Engineering, Social Sciences, and Physics, in order of reported frequency. Sub-disciplines were not documented.

11. Does the program portfolio have appropriate participation of underrepresented groups? Appropriate

Comments: PGRP recognizes and promotes the importance of increasing the participation of underrepresented groups in all of areas of science. In the review of the information provided in the NSF Highlights for PGRP (FY2007-FY2009), the PGRP documented outreach activities at academic institutions, professional society meetings and conferences to encourage broader participation by underrepresented groups. It is clear that the outreach goals are taken seriously by the community of PIs as evidenced by grant-associated activities, some of which are described in the NSF highlights document. In years for which there is more than a single application from an MSI (i.e., FY2007), the success rate for these applications is on par with the success of the total pool of applicants. Because minority involvement numbers are based on self reports (with a low ~25% reporting rate), COV cannot draw overarching conclusions until more comprehensive data can be obtained. *Recommendation:* If strong conclusions are to be made regarding the impact of efforts to improve participation of underrepresented groups, the PGRP needs to identify and implement ways to encourage the submission of demographic information by self reporting.

12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Appropriate

Comments: COV review of the PGRP annual reports for FY2007 and FY2008 support the notion that PGRP is funding awards that address highly relevant issues of national significance and priority (summarized below), the mission of the NSF and issues of concern and importance to broad constituency groups. National Priorities: The National Science and Technology Council (NSTC), a cabinet-level council, is the principal means within the executive branch to coordinate science and technology policy across the diverse elements of the Federal research and development enterprise. An important function of the NSTC is the establishment of clear national priorities for Federal science and technology investments including basic research. The NSTC Committee on Science's Interagency Working Group (IWG) on Plant Genomes is responsible for coordination of the National Plant Genome Initiative (NPGI). The ultimate goal of the NPGI is to understand the structure and function of all plant genes at levels from the molecular to the organismal and to interactions within ecosystems. The new knowledge and insights gained from plant genomics will lead to unexpected discoveries and conceptual advances in our understanding of the biology of plants. With a focus on plants of economic importance and plant processes of potential economic value, the NPGI will impact applied research related to agriculture, natural resources, the environment, health, and plant-based industries. Examples are given in other sections of this document.

13. Additional comments on the quality of the projects or the balance of the portfolio: *Recommendation:* The COV feels that the concept of 'appropriate balance' is one for which the program should provide more input about programmatic goals.

A.4 Management of the program under review. Please comment on:

1. Management of the program. The COV had the impression that PGRP has an unusually high workload relative to staffing. More specifically, PGRP at one time had two program officers, but now has a single permanent officer along with two rotators. While rotators are essential to the program, they do not provide the continuity that is a significant advantage in managing large or complex projects, including cooperative agreements. The COV identified several reasons for the high workload, including the large scope of some projects, monitoring projects with multiple collaborators, and the tightly managed post-review and pre-award process, which includes PI response to ad hoc reviews and panel comments, and covers the research project, management plan, and data deposition. The COV emphasizes that it views tight program management in a positive light as it leads to more efficient use of funds, for example by avoiding duplication of efforts in the public or private sector, or use of outdated technologies. The program appeared to spend considerable effort to fine-tune projects that are being considered for funding. Other post-award communications such as annual reports were deemed appropriate by the COV.

Recommendation: The COV strongly recommends adding another permanent program officer to PGRP.

2. Responsiveness of the program to emerging research and education opportunities. The COV felt the program was responsive to emerging research opportunities in three ways. One is through the development of successive NPGI five-year plans, which rely in part on significant stakeholder input including participation of the NAS, specific workshops, the annual awardees meeting, and interactions at various scientific meetings. Second, PGRP uses RAPID and EAGER mechanisms to fund pilot projects or proposals addressing immediate needs at low cost, although no RAPID proposals were funded in the period reviewed here. Finally, the implementation of heterosis challenge grants was an example of a response to an area where there was clearly an important need, but the existing program solicitation was not meeting this need.

Recommendation: The PGRP continue to use RAPID, EAGER and challenge grants where a key emerging research opportunity is not yet generating sufficiently highly meritorious proposals in response to the annual program solicitation.

The COV considered PGRP responsiveness to education opportunities in two contexts. One was, broadly speaking, in the area of national science literacy; the other concerned pipeline issues as they relate to ensuring an adequate work force to realize the medium and long term goals of PGRP. In terms of science literacy, the COV recognized the participation of PGRP projects in outreach and training for K-12 constituencies, and the visibility of some PGRP results in the public sector. Both these activities enhance understanding and appreciation of science, but their effectiveness is challenging to assess in terms of either a possible increase in science literacy, or in the eventual attraction of underrepresented groups to plant science careers. The uneven use of education assessment tools, and the voluntary reporting of minority status, both contributed to uncertainty on the COV's part as to the value of these efforts.

Recommendation: PGRP continues to support outreach activities to enhance science literacy for the general public and K-12 students, but not increase these efforts.

The COV recognized the NPGI's five-year goal of "translating basic discovery to the field" will require an appropriately trained workforce to populate the relevant enterprises in the public and private sectors. While PGRP awards fund postdoctoral fellows and graduate trainees, these allocations may be insufficient to ensure sufficient domestic competitiveness in downstream professions including academia, agriculture and agricultural biotechnology, and international relations as they relate to agriculture. The COV felt that strong justification could be made for targeted PGRP funding for both postdoctoral and graduate training. A targeted postdoctoral program could increase training in areas of particular importance in a more distributive fashion, rather than concentrating that training in one or a few projects. It could also be designed to attract recent PhD recipients from outside plant science, and/or to promote retention of highly qualified domestic plant science PhD recipients. A postdoctoral program could also facilitate entrepreneurial projects, while accomplishing the secondary goal of training in proposal preparation and grant management to the recipient.

Recommendation: PGRP should consider a postdoctoral fellowship program as part of PGRP to increase domestic competitiveness in plant genome-enabled research and translation.

The COV felt that attraction of domestic applicants into plant science graduate programs is a significant bottleneck in terms of long-term U.S. competitiveness in plant agriculture. Declining institutional support for graduate programs, coupled with a predominant lack of access to NIH training grants for plant-specific programs, tend to drive a proportion of the most highly qualified potential students to other fields of biology, and could create disincentives for faculty to select graduate trainees over postdoctoral fellows. The COV felt that while the IGERT mechanism serves a certain need in enhancing multidisciplinary training, its impact on the above-stated need has not been significant. Graduate training grants, while costly, could create a nexus of trainees who would receive instruction in multiple aspects of plant genome-related research, including for example systems biology, bioinformatics, genetics, etc. Such programs generally also include a core curriculum which ensures relevant skills in speaking, writing and networking. Training grants also generally fund several years of a PhD program, usually enabling the student to join the laboratory of his/her choice, which would have the outcome of diversifying the training milieu and engaging more faculty in PGRP research priorities.

Recommendation: PGRP should consider implementation of a program-specific graduate training program competition. Additional funds may be required to underpin this effort.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. The integration of the NSF and other agencies into the Interagency Working Group through the NPGI has resulted in a well-coordinated effort to promote plant genome sequencing and associated functional genomic efforts across disciplines. Overall, the PGRP has made, and continues to make excellent use of both external and internal resources to guide its planning and prioritization. The COV found that the PGRP and NSF leads the way for other programs through effective management and administration of funding priorities. Some discussion occurred regarding differentiation of USDA and PGRP priorities given language in the January 2008 NPGI Progress Report under "Plans for the Next Year". The statements from PGRP and CSREES appeared rather similar, although PGRP staff assured the COV that frequent discussions led to complementary rather than duplicative award portfolios. The COV viewed Dr. Silverthorne's knowledge and contacts from two years at OSTP as a strong benefit to the long-term management of the program. In addition, the COV recognized that PGRP uses a multifaceted approach to establish funding priorities including attendance at scientific meetings, and the annual awardees meeting.

Recommendations: No changes recommended.

4. Responsiveness of program to previous COV comments and recommendations. In general, responses to the previous COV recommendations were felt to be satisfactory. In fact, many of the suggestions were already in place at the NSF before the COV of 2007. In particular, PGRP has shown continued commitment for research related to global climate change, plants important for the economies of developing countries, and comparative genomics and biodiversity. Other COV suggestions that were well addressed are in the area of development of means to disseminate genomic information to plant scientists using visualization and graphic tools. This suggestion was implemented in the 2009 program solicitation in a request, under tool development, for "improved visualization tools". There were a few unresolved concerns raised by the 2007 COV that were seen to be out of the scope of the PGRP. These included BIO-wide or NSF-wide issues, including suggestions of how to improve workload problems of the program managers or problems with failure of suggested ad hoc reviewers to return reviews. The COV noted that while BIO had recommended consideration of mechanisms such as peer-reviewed letters of intent, triage, or preproposals in order to reduce staff and PI workload, PGRP felt that casting a wide net in the sense of not excluding any proposal from full consideration, was likely to result in the optimal award portfolio. PGRP also feels that these mechanisms would ultimately not reduce workload significantly. The COV generally concurs with this view, while recognizing that workload issues on the part of panelists and *ad hoc* reviewers will persist under the current system.

5. Additional comments on program management: None.

PART B. RESULTS OF NSF INVESTMENTS .The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards. NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made. To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.*"

Comments: PGRP has established, and manages, a unique and broad portfolio of genome-related and genome-enabled fundamental plant science. In the period reviewed by the COV, a diverse set of species were examined from the standpoints of gene function, tool development, and basic biological mechanisms. Because PGRP focuses on plants of economic importance, its relevance to national strategic goals is indisputable, and training conducted by PGRP (see B.2) is a key component of workforce development within the public and private sectors. As a part of NPGI, PGRP develops platforms that can be leveraged by partners (e.g. USDA) in their own programmatic activities. Furthermore, PGRP interfaces well with the core programs within and outside of BIO, and uses its venture fund when appropriate to ensure that relevant research is adequately supported whether the proposal is initially considered within PGRP or elsewhere. While PGRP has made awards which utilize numerous plant species, special efforts have been made to create broader knowledge and tool bases for several reference species. In the period examined, the completion of the maize genome and investments into tomato, which will inform studies throughout the Solanaceae, are two examples. Many other highlights were noted, including the rice expression atlas, new or refined tools for plant molecular modification, exciting findings related to small RNAs and signal transduction, comparative genomics, insights into domestication, the plant-environment interface, and plant interactions with other organisms. The COV noted that many of these discoveries accomplish objectives stated in the recently-completed 2003-2008 NPGI plan. Furthermore, ongoing efforts clearly begin to meet the objectives of the 2009-2013 plan, including elaboration of new reference genomes, and comparative genomics. Finally, PGRP funded a number of workshops, cognizant that new and transformational ideas often arise in these contexts. In summary, the COV commends PGRP for its high-quality portfolio of basic research that meets both NSF mission goals, and also more specific goals related to the future of agriculture, including outcomes relevant to climate change, bioenergy, and nutrition.

B. Please provide comments on the activity as it relates to NSF's Strategic Goals

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

Comments: The COV recognizes that funded PGRP projects contribute to learning in a number of diverse ways including training of the next generation of plant scientists and improving the scientific literacy of the US population in general. First, the PGRP provides training opportunities for students at all levels. In particular the PGRP funds the training of undergraduate, MS, PhD and postdoctoral students. Because of the multi-disciplinary nature of the PGRP program, students on PGRP projects are exposed to a diverse set of disciplines including plant biology, genomics, bioinformatics, statistics, math, computer programming, data management and systems biology among many others. This represents a unique pool of human resources that has already begun to influence the face of US science in general. *Recommendation: PGRP should encourage PIs to include project personnel (including PhD students, postdocs and undergraduates, if appropriate) to participate in all project meetings to further enhance the multidisciplinary nature of their training. If a postdoctoral program were established as recommended in Section A4.2, the COV recommends that these postdoctoral associates be invited to participate in the annual PGRP Awardees meeting. Similarly, a graduate training program would address this issue.*
The PGRP also contributes in many ways to the expansion of the scientific literary of all US citizens and the broadening of participation of underrepresented groups. Here, the COV highlights a few exciting examples that illustrate how the PGRP achieves this goal.
- An award made to Jonathan Wendel (Iowa State Univ: 0638418) enabled the production of a 20 min educational video titled "Secrets of Plant Genomes: Revealed!" by Twin Cities Public Television. The entertaining video highlights plant genomics and the importance of plant crops (including corn, potato and cotton) in agriculture and everyday life. The video is aimed at middle and high school students and has been distributed to almost 3000 K-12 teachers in the US.
- Several awards have aimed at broadening the participation of Native Americans in the plant sciences. In particular, one award funded a training program for undergraduate students at Tribal Colleges and a second funded an integrated training program for faculty, students and community members at Little Big Horn College.
- An award made to Susan McCouch (Cornell; 0606461) has enabled a unique international cooperative arrangement with IRRI (Philippines) to provide training in rice breeding to 25 students per year.
- A grant awarded to Richard Jorgensen and Carolyn Napoli (University of Arizona; 0421679) funds summer internships for K-12 teachers in bioinformatics. This project thus targets a critical need in the US educational system.

Note: The COV feels that it is extremely difficult to conduct a thorough analysis of this Outcome Goal without access to specific data (e.g. #'s of PhD students trained, #'s of Postdoctoral Associates trained, etc.). This comment is addressed in more detail in C.3.

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"

Comments:

The 2007 CoV recommended the formation of the Plant Science Cyberinfrastructure Collaborative program (PSCIC). The goal of this program is to create a new type of organization – a cyberinfrastructure collaborative for plant science. In response to this recommendation and with community input, the PSCIC program developed the iPlant initiative which was initiated, but is not managed by the PGRP program.

The CoV recognized that the PGRP funded projects have short, medium and long term data needs. The short term needs include standardized data storage, organization, archiving and viewing. PGRP is currently sharing in the funding of following databases: MaizeGDB, Gramene, SoyBase, PlexDB, PlantGDB, Legume Information Service, SOL Genomics Network (SGN), Genome Database for Rosaceae (GDR), and PlantCyc.

Support for these databases includes incorporation of short term data needs and is apparent through the large projects including sequencing of the maize genome (Wilson, 0910642) and individual tomato chromosomes (Giovannoni, 0820612). In addition, the development of DNA markers has been supported which, like genome sequence, is directly applicable to crop improvement through breeding (Buckler, 0638566). Further efforts for short term data needs has also come in the form of workshops and genome specific annotations to improve the understanding and usage of these data and databases. Continued encouragement and support of interagency standardization of data management and use of these databases is encouraged by this CoV.

Medium term data needs, including development, improvement and maintenance, and broadening the use of analytical software tools, was identified as an important issue by the CoV. From discussions with NSF personnel, it was indicated that these issues were being approached through intra and interagency projects. However, the CoV felt that additional efforts and funding mechanisms within PGRP are needed to improve data handling and widening community access to analytical software tools.

Long term needs for data visualization, metadata access, storage and analyses have been recognized as significant issues which led to the iPlant initiative. The CoV had no means to determine whether iPlant will meet the current and future needs of PGRP-funded projects.

PGRP has been instrumental in tool development for plant biology studies over this period. These projects support transformative research by developing, sharing and maintaining tools for current and future scientists. Many of the awards in the PGRP Highlights document fall under this category of infrastructure, including a tool to define rice gene expression (Nelson, 0325821), an antibody resource directed at cell wall components (Hahn, 0421683), and software for zinc finger nuclease design for targeted gene insertion (Voytas, 0923827). A unique robotic phenotyping infrastructure system has also been funded (Spalding, 0621702). This type of research is another example of NSF's support of infrastructure for plant genomics.

PGRP continues to support the discovery and production of unique germplasm resources (e.g., mutant lines) for transfer to stock centers which are funded by other agencies. Some of the materials include maize fluorescent-tagged lines (Jackson, 0501862) and ChromDB (Napoli, 0820975). Continuation of this interagency effort is essential.

PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

The COV found the PGRP to be well managed and effective in its solicitation, review and funding of meritorious proposals on a wide range of topics dealing with plant genome research and related technologies. Recommendations can be found throughout Sections A and B.

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

See comments in Sections A and B.

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

The COV calls attention to certain agency-wide issues, cognizant of the fact that PGRP is likely aware of them, and that the issues may be in the process of resolution.

Issue 1: Restricted ability to evaluate project outcomes. The Project Reports System collects valuable data, but only manual methods can collate it. The COV understands that a significant evolution of the Reports System is in progress. Examples of metrics that the COV would have found extremely valuable relate to:

Breadth of research portfolio:

- Disciplines and subdisciplines covered
- Tools to be developed (such as videos, software, databases)

Research outcomes:

- Information of number of downloads of software or other tools developed as part of PGRP funded projects
- Number and impact of publications for each award (as defined in the current Project Reports system), and the associated cumulative bibliography
- Intellectual property developed
- Other quantifiable research outcomes (sequence depositions, additions to databases, etc.)

Broader impacts:

- Number of graduate students and postdoctorals trained, and next career step
- Number of undergraduate students involved, and next career step
- Participant demographics when reported

The COV could in principle gather some amount of this information by reading project reports, but because of time constraints this is not realistic, nor is it realistic to demand this of program staff in real time.

Issue 2: Lack of guidance in broader impacts text in proposals, either in new proposals or in describing results from prior support:

- Applicants use highly variable amounts of space in describing Broader Impacts, impinging on project descriptions and thus including very different amounts of detail. Placement of this requirement in a page-limited Appendix (as done for the Management Plan) would solve this problem.
- The detail in reporting broader impacts from prior support (e.g. in renewals) is highly variable, ranging from lists of names to brief summaries. The lack of guidance leads to some investigators being under-recognized for their efforts, and considerable uncertainty on the part of PIs, particularly junior PIs, as to what is expected. At the other end of the spectrum are NIH Training Grants, for example, where very specific guidance on reporting training outcomes is given.

Issue 3: Challenges in understanding the long-term goals and progress in broadening participation.

The COV recognizes the value of broadening participation and supports the principle. However, the low level of self-reporting, the lack of information as to any bias in who self-reports (e.g. minorities may under- or over-report themselves), and the absence of targets, which perhaps should be region-specific, or at least not be uniform, results in rather anecdotal reporting. This makes it difficult for NSF to know if current efforts are taking participation in the right direction, or whether any broadening of participation is occurring independently of NSF efforts.

C.4. Please provide comments on any other issues the COV feels are relevant.

See Sections C3 and D.

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

1. Provide a more explicit set of instructions for the COV Chair and panelists in the Readme File to facilitate a more efficient use of time at the meeting. Particularly helpful would be a potential breakdown of workload assignments for individuals or groups that reflect the aggregated wisdom of previous COV committee Chairs (eg. what to read ahead of time, things to avoid, etc).

2. It would be helpful if all components of a given jacket could be downloaded as a single document, or if specific parts of all jackets could be downloaded (eg. all panel summaries for the portfolio).

3. The panel Wiki should be made available for comments prior to the COV meeting.

SIGNATURE BLOCK:

J. Clark Lagarias Sept 2, 2010

_____ For the PGRP COV 2010 J. Clark Lagarias, Chair

PART D. PROGRAM LEVEL QUESTIONS

PGRP would like your advice about several questions related specifically to the program.

D.1 What new opportunities in plant genomics should the Program address?

The January, 2008 National Academies report[1 ⌖I#_ftn1] provides some thought-provoking ideas where PGRP could consider adding emphasis. These include addressing plant adaptation to various ecological niches, metagenomics of living communities (e.g. plants and their endophytes, endosymbionts, etc.), the biology of invasive and parasitic plants, field-robust phenotyping methods, identification of small chemical signals and development of chemical probes, and single-cell omics (proteome, ionome, metabolome, transcriptome). It should be kept in mind that such emphases would generally be in the context of hypothesis-driven research that will advance our understanding of biological systems at multiple scales, from cell to community. Numerous opportunities for population-level genome analysis, sequencing of wild accessions, and deep evolutionary exploration will arise as per-base costs are expected to plummet in the next few years. PGRP should monitor these developments and consider challenge grants as appropriate.

The COV strongly recommends broadening the PGRP's portfolio to encompass the diversity of both agronomic and nonagronomic plant species best suited to address the biological process under study.

[1 ⌖ I#ftnref]_Achievements of the National Plant Genome Initiative and New Horizons in Plant Biology

D.2 How best should the Program manage *in silico* resources?

1) Many PGRP projects are interdependent on efforts of the iPlant initiative that is managed outside of IOS. PGRP should shepherd a more transparent coupling of research infrastructure development projects funded by PGRP with the iPlant initiative.

2) The PGRP should continue to encourage the use of a few 'standardized' databases for data deposition for PGRP-funded projects, eg. for omics data, data visualization,with existing standards for highly used data repositories, eg. NCBI, TAIR, and Gramene.

3) The PGRP should be cautious about funding new databases, but should maintain/improve the most highly used ones. While PGRP is committed to development of new software tools, it is not clear which agency has the role of long-term maintenance, organization and integration of them. This should be a topic under consideration by the IWG.

D.3 What are the most effective approaches for ensuring that scientists at all levels are equipped with appropriate skills to participate in multidisciplinary, collaborative, and integrative research?

COV believes there are two germane populations to consider, namely independent faculty and junior scientists (mainly postdoctoral fellows and graduate students). In the latter case, appropriate mentorship during participation in this type of research will engender appropriate skills. For example, an appropriate postdoctoral training plan will expose the scientist to all aspects of a collaborative project, and develop experience with respect to data sharing, authorship, coordination and communication. For graduate students, the situation is more nuanced as any training plan must fit into the context of university or graduate program-specific requirements. However, in the day to day conduct of research, the same issues are regularly confronted, and PhD students should be involved in, rather than shielded from these aspects of multi-institutional projects. Program solicitations do not appear to directly address these issues, although they could be construed as relevant to the Project Description/Plan to integrate research and education, and/or the Management Plan. *PGRP should consider being explicit in asking applicants to address the graduate student and postdoctoral experience in terms of this issue.*

The COV also notes its recommendation that PGRP consider program-specific postdoctoral fellowship and graduate training modules. A requirement for skill development relevant to multidisciplinary projects would be very likely integral to such programs. In the case of graduate students, it is likely that site training grants (e.g. a multi-student grant located at a single institution) would specifically involve their trainees in collaborative projects, and embody appropriate curricula to underpin their skill development. This would create a very different experience than a PhD student funded by GRFP, which rewards a small number of highly qualified PhD students across NSF Directorates and Offices, but relies on existing institutional mechanisms for their training.

Commensurate skill-building in independent scientists, whether or not tenure-track, is a much thornier issue. Scientists live under institutional constraints and expectations which are relevant to promotion or even continued employment. Clearly, one concern is whether institutions have appropriate mechanisms to evaluate individual faculty contributions to collaborative projects. On the other hand, multi-institutional or intra-institutional large projects often garner signficant publicity and financial resources. The COV therefore believes that it is institutional interest to encourage faculty to pursue such projects both from the point of view of these practical considerations, and also from the perspective that this type of project can take science in directions that would otherwise not occur. It is of note that such approaches have been common for many years in fields such as physics, but are relatively new to biology. However, claims to a "Manhattan Project for Bioenergy" (*Nature* 446:106) imply that plant biology has entered this era.

NSF can and has taken steps towards encouraging or inviting scientists who might not otherwise "connect" into collaborative contexts. Workshops and sandpits are two examples of such mechanisms. *COV encourages PGRP to continue such efforts, with the proviso that their success can be meaningfully evaluated.* It is doubtful that PGRP should attempt to work directly with institutions, although *period visits to institutions to explain PGRP programs are valuable and should certainly continue.* In summary, by skill building at the postdoctoral and graduate student level, an increasing proportion of independent scientists will be accustomed to multidisciplinary research, institutions will have adapted evaluation mechanisms to account for different scientific styles.

COV emphasizes that not all PGRP-related research need be, or should be collaborative or multidisciplinary. Indeed, PGRP reported a substantial number of single-PI grants in the period evaluated (27% of all awards). So, the question posed above should be viewed as germane to an additional mode of science, not a replacement of single investigator-initiated proposals.